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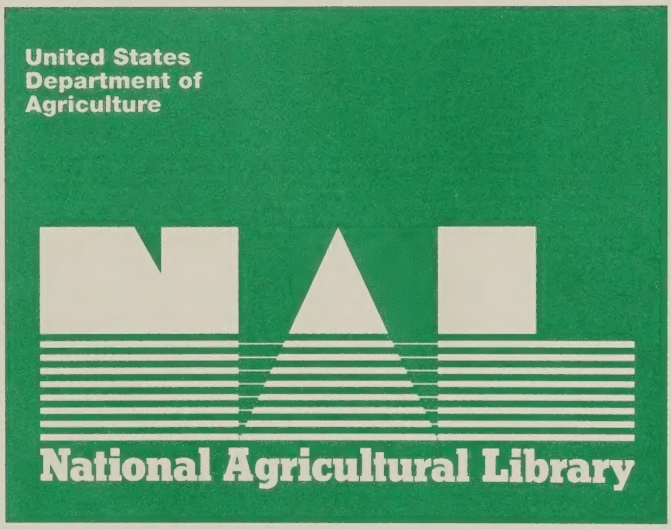
Missoula Technology & Development Center

Forest Pest Management 5-Year Program

Supporting Forest Health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Missoula Technology & Development Center

Forest Pest Management 5-Year Program

Supporting Forest Health

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MTDC/FPM 5-YEAR PROGRAM

Supporting Forest Health

I. INTRODUCTION

Purpose

The purpose of this plan is to outline a 5-Year program and describe the process for the administration of the USDA Forest Service (FS) Missoula Technology and Development Center/Forest Pest Management (MTDC/FPM) 5-Year Program - Supporting Forest Health. This plan is an update and continuation of the previous plan which began in FY93.

Background

MTDC is an engineering support organization currently under the management of the Director, WO Engineering. The MTDC organizational chart is enclosed as Appendix B. MTDC has been working in partnership with FPM since the establishment of MTDC in the early 1960's, providing technical support and engineering services to entomologists and pathologists. This support has included engineering consultations, literature searches, equipment design, computer model development, ambient weather instrumentation, equipment testing and on-site equipment and instrumentation support. With the increased emphasis on ecosystem management and the objective of a sustainable, diverse and healthy forest ecosystem, it is envisioned that the role of technology and development within the FS will increase to aid in supporting ecosystem approaches. Changing objectives require changes in methods which require the utilization of different and/or new technologies. Therefore, MTDC/FPM are updating this jointly developed plan for the allocation of resources to accommodate current and emerging needs.

FPM's technical needs are mostly identified through FPM's national steering committees. The committees, made up of FS scientists and foresters from NFS, Research and S&PF, the States, academia, and industry, identify national needs based upon priorities and recommend those that should be approved and funded. High priority needs, selected from the needs list, serve as the core group of projects that make-up this MTDC/FPM 5-Year plan. MTDC achievements in fulfilling the plan to date are included as Appendix B.

II. MTDC/FPM 5-YEAR PROGRAM

A. Facts Bearing on the Plan

1. Environmental and economic considerations continue to focus effort on minimizing the amount of material introduced into the environment to mitigate unintended impacts. Regulatory environmental considerations require total accountancy of released material. The pursuit of the dual goals of minimization and accountancy, along with the development of new, safer materials will guarantee the safe use of pesticides by USDA-FS.

2. MTDC is ideally staffed and enthusiastic about the pursuit and development of new technologies for FPM. The systematic, long term view offered by this approach allows MTDC to rationally plan the accomplishment of specific long-term objectives.

3. Projects listed are priority technical needs that have come from FPM regional staffers and have been prioritized in the FPM National Steering Committees.

4. All projects require engineering and/or physical science disciplinary leadership.

5. Projects will be closely monitored and reviewed annually. Projects may be cancelled or revised as field needs and budgetary necessities dictate.

6. Field Sponsors and contractors will be used, as appropriate,as consultants and to obtain technical services under the leadership of a Project Leader.

7. The MTDC/FPM 5-Year Program is separate from the FPM Technology Development Program. MTDC is a resource and does not see its role as a direct competitor for FPM Technology Development Funds.

8. The MTDC annual budget contains no general and administrative (G&A) funds such as would be used to cover utilities, facility, and administrative costs. These costs must be paid for by assessing annual project funds. This assessment is currently 32%.

9. MTDC will be an eager competitor demonstrating its capabilities through deliverability as the FS transitions into enterprising partnerships.

B. Assumption

1. MTDC will have qualified and experienced personnel available as Project Leaders.

2. MTDC will perform the projects that it accepts on schedule and on budget.

3. Funding will be available within the constraints of tight monetary policy.

C. Discussion

This plan is a continuation and update of the existing MTDC/FPM 5-Year plan of December 1991. There are 12 projects included in this revised plan. Seven are on-going, one will begin in FY95 and four were previously tasks under other projects.

The new project was requested by regional FPM staff. The project cost estimates provided herein are based on a level of effort and project objectives approved by Jack Barry, FPM Sponsor/Coordinator, and the FPM field sponsors. The estimates reflect the costs necessary to achieve the specified objectives.

III. PROCESS - 5-YEAR PROGRAM

A. Field Sponsorship. Field Sponsorship is basic to establishing and initiating a project and is critical to project success and to timely technology transfer. Successful product development and Technology Transfer requires that the deliverable fulfills a direct need of operational FS personnel.

B. Project Work Plan. Project work plans are included in the 5-Year Plan update for review by the FPM Sponsor/Coordinator. This review will serve to insure that the projects are proceeding as planned and are within budget and on-schedule. The plans will be adjusted as directed by the FPM Sponsor/Coordinator. This approach is critical in engineering development work where the desired result is typically fairly clear but the optimal means of achieving that result is not necessarily known at the outset of the project. The project work plan serves as a 'project blueprint'. The structure established by the work plan offers a benchmark to reference as the project evolves. The project plan will present action items and deliverables.

C. Annual Program Review. Annually the Manager, MTDC; MTDC/FPM Sponsor/Coordinator; Program Leader; Project Leaders (FPM Projects) and available Field Sponsors will meet at MTDC to review program status, accomplishments and needs, as well as to revise projects as needed. New and high priority engineering projects will be discussed and recommendations made as appropriate to Director, FPM.

D. Program Management and Coordination Responsibilities. Program management responsibilities are as follows:

Director, FPM

Responsible for approving, funding and monitoring the MTDC/FPM 5-Year Program.

Manager, MTDC

Responsible for managing the MTDC/FPM 5-Year Program, project reporting and annual updating of the Program Plan.

FPM Sponsor/Coordinator

WO/FPM Staff Sponsor responsible to Director, FPM for monitoring progress of the program and the individual projects; and coordination of project needs and projects with FPM Field Sponsors as needed.

E. Program Funding. The proposed program funding is described below.

Projected Project Budget

	1995	1996	1997	1998	1999
Technical Services	55	55	80	95	125
Technical Transfer of Computer Models	50	50	70	85	115
Ground and Aerial Pheromone Applications	15	--	--	--	--
Ground Sprayer Characterization and Modeling	20	20	10	--	--
Single Tree Sprayer	15	25	35	20	--
GPS Based Aircraft Navigation and Guidance	60	15	15	15	15
Thermal Insect Control	60	20	--	--	--
Meteorological Factors in Pesticide Drift	20	30	30	45	50
Pesticide Drift in Complex Terrain	20	20	30	45	50
Vegetative Canopy Barriers and Pesticide Drift	10	55	50	35	35
Non-Chemical Orchard Cone Sanitation	5	40	55	35	25
Computer Assisted Sketch Mapping	10	10	--	--	--
	340	**340**	**375**	**375**	**415**

F. MTDC/FPM 5-Year Plan. The aggregate of Project Work Plans including descriptions, major actions and cost estimates will be the MTDC/FPM 5-Year Plan. The plan will be maintained by Manager, MTDC and updated annually after the annual program review. Projects will be added, dropped, or revised based upon discussion with the FPM Sponsor/Coordinator.

IV. PROJECT JUSTIFICATIONS AND WORK PLANS

A. TECHNICAL SERVICES - TE02P18

Project Description

The objective is to provide prompt technical services on request, and to coordinate program planning support to the sponsoring Washington Office unit. At the request of the Forest Pest Management Staff, the Center conducts special investigations and studies; participates in field programs; contacts field personnel to determine instrumentation and equipment needs; delivers presentations on Forest Pest Management methods at training sessions, meetings, and workshops; provides follow-up services on completed development projects and answers requests for information from field units, Government Agencies, and industry; publishes reports; prepares manuscripts for journal publications; and handles program planning and Washington Office coordinator activities for Forest Pest Management projects at the Center.

Background

MTDC represents a unique resource of people, knowledge, professional and technical skills, and is the only source of mechanical and electrical engineers in the Forest Service other than those in FS Research. Historically, FPM has called upon MTDC for immediate and short term professional judgements, on-site support, contract specifications, equipment evaluations, drafting, editing, publication, and assistance in Technology Transfer activities. Need for these services will, at a minimum, continue at current levels and likely will increase and the FS continues to face complex resource management issues.

Justification

The justification for a general technical services project is based on the need for short turn around engineering answers and equipment for specific questions and needs which arise with short notice. Further, this general task includes Technology Transfer which is a primary component of effective utilization of techniques developed at MTDC for FPM.

Activity Schedule

Project Action

1. Attend National meetings and workshops, present papers and prepare manuscripts for journal publication.

2. Act timely on routine requests and inquiries; including publishing, illustrating and photo.

3. Provide equipment and meteorological support to FPM and their cooperators in field projects.

4. Coordinate MTDC project capabilities with requests from Regions, NA, WO, and FPM units.

5. Complete reports for terminated projects and status reports.

6. Initiate new projects as directed by FPM WO (assignments subject to revision).

Schedule of Deliverables

The deliverables under this project are field equipment and support, technical presentations, and training sessions which will be produced as the opportunities allow. Peer reviewed journal articles will also be considered deliverables under this task. MTDC should set a goal of 4 technical presentations or training sessions and one peer reviewed publication a year.

B. TECHNICAL TRANSFER OF COMPUTER MODELS - 5E52P29

Project Description

The objective of this project is to support the technical transfer of models that support the safe and effective application of pesticides. Mathematical models have been developed that use descriptions of meteorological processes and descriptions of application methods and equipment to simulate dispersion and deposition of airborne materials. Models have been improved and verified based on field trials. Analysis of data is on-going. Training in the use of the models began in FY 1988 and will continue as the models evolve, become more encompassing and are enhanced with decision support systems. In FY95, a complex terrain dispersion model will be incorporated into the FS system of models.

Background

MTDC has played an integral role in the development of the FS spray dispersion models. The modeling system currently in use (FSCBG) consists of two basic model types with a third to be added in FY95. The far-field model is Gaussian and has been adopted from US Army models. The near field model is a LaGrangian transport model which has been developed under contract to the FS, the third and newest part is a phenomenological model describing transport in complex terrain. Both the near field and the complex terrain models have been developed under contracts overseen through MTDC. The third model has been over seen by FPM in close coordination with MTDC.

Justification

Model development has been carried on under the management of MTDC/FPM engineers and scientists and with guidance of the FPM National Steering Committees. Accurate calculation of the amount of material applied and the location it is deposited allows the two goals of minimization of the amount of material applied through accurate application, and total accountancy of applied material through detailed knowledge of the physical phenomena involved, to be attained.

Activity Schedule

The development of appropriate algorithms will be covered under other tasks. Incorporation into the FSCBG modeling system and debugging of computer code will be completed under this task.

Project Actions

1. Continue training and technology transfer of the FSCBG modeling system.

2. Support incorporation of the FSCBG modeling system into decision support systems such as GYPSES and into expert systems such as those being developed jointly with New Zealand FRI.

3. Assist FSCBG User Group in conducting training sessions and in keeping user materials and information current.

4. Complete interface of complex terrain spray drift model (ValDrift). (See Workplan J.)

5. Incorporate the latest knowledge on droplet evaporation and droplet size distribution into the FSCBG system database.

6. Research and improve algorithms which describe canopy interception of spray droplets. (See Workplan K.)

7. Continue to provide support for systems management and implementation of existing models while supporting the introduction and application of new models.

Schedule of Deliverables

FY95 - A prototype FSCBG system incorporating ValDrift

FY96 - A finalized FSCBG system incorporating ValDrift

FY96 - An improved evaporation algorithm incorporating non-water evaporation.

FY98 - An improved canopy interception algorithm.

C. GROUND AND AERIAL PHEROMONE APPLICATION EVALUATION - 3E22P82

Description

The overall objective is to help make available equipment and procedures for applying pheromones both aerially and on the ground. Methods and equipment need to be investigated, evaluated, and possibly developed for dispersing pheromones in tubes, capsules, flakes, pellets and granules. Investigate solid dispersal systems, how pheromones are currently dispersed, and in what forms they can be obtained.

Background

Pheromones are chemical substances released by animals and insects, which have an odor that becomes a means of communications between species. The release of pheromones is sometimes used to establish territories, provide a warning mechanism, or to attract other members of the same species. Pheromones are usually gaseous in natural state. These pheromones can be produced synthetically and can be used to cause communications disruption between the insects or used to warn the insects to leave the area. Because the pheromones are usually gaseous, there has to be a mechanism built into the synthetic product to allow controlled release over a period of time. The time release mechanism is accomplished by encapsulating the pheromones in plastic polymers that will break down over time. The end product can be packaged in many forms, from plastic granules to spaghetti like tubes or strings and are aerially applied with adapted granule applicators or manually placed in the treatment area.

Justification

This project has been identified by FPM national Steering Committees. The increasing success of this technology will supplant the use of synthetic chemical pesticide in certain cases supporting the USDA goal of reducing use of chemical pesticides. Pheromones are generally viewed as less noxious to synthetic the environment in general than synthetic chemicals.

Update

It is the feeling of the project leader that more fundamental development and pheromone trials are necessary before development of delivery systems can proceed on a large scale. As the ecological timing, triggering mechanisms and environmental dispersion of these materials becomes better understood, this project may need to be revisited. A final report will be prepared in FY95 outlining work to date, contacts made, problems and needs identified, and making specific recommendations.

Activity Schedule

Project Actions

1. Continue reviewing literature and contacting manufacturers and research scientists to determine current state of the art, needs, and opportunities.

2. Determine the application equipment that has the highest potential value for adaptation to pheromone application, considering both the method of encapsulation and the application equipment itself.

Schedule of Deliverables

FY95 - Prepare a summary report specifying the application methods that will be targeted for evaluation.

D. AIR ASSISTED GROUND SPRAYER CHARACTERIZATION AND MODELING - 3E22P80

Description

The objective of this project is to make it possible to predict ground spray behavior by characterizing the spray plume, spray deposition, and spray drift from ground sprayers used in seed orchards urban forest, and other forestry related situations, and then enhancing and evaluating the FSCBG model system for use in predicting drift from ground application of pesticides.

Background

Computer models are used to predict the airborne drift of pesticides released from aircraft in aerial spraying. In order to utilize these models, it was necessary to first determine the characteristics of the aerial spray droplets. Nozzles and droplet size distributions for ground applications differ from those of aerial applications. For modeling purposes, it is necessary to know the exit speed and angle of droplets exiting the nozzles. The FSCBG aerial spray model system was developed for aerial application of pesticides. It is widely used for that purpose and there are large groups of trained users. The near field model (AGDISP, LaGrangian transport model) has a ground application module, but it has never been validated.

Justification

This project has been given high priority by FPM National Steering Committees. It is widely perceived that less drift occurs from ground sprayers than from aerial applications. It is therefore foreseen that ground based application will increase in forestry.

Update

The USDA Forest Service has not adopted ground spraying techniques on a large scale. Use is limited to seed orchards, plantations, and other small area, specialty situations. An increase in ground spraying activity was anticipated as a drift mitigation measure, however, other technologies are being implemented to achieve minimization of drift. Therefore, this project is being drawn back into a maintenance mode and will be closed in two years with a final report barring unforeseen developments or a renewal of interest in the FPM user community.

Activity Schedule

Project Actions

1. Ground sprayer modeling technology will continue to be monitored and major developments noted.

2. A report closing out the project will be written in FY97. Even if there is little activity in FY95 and FY96, previous activity needs to be captured in a Final Report.

Schedule of Deliverables

1. FY97 - Final Report

E. GPS BASED AIRCRAFT NAVIGATION AND GUIDANCE - 3E12P73

Description

The objective of this project is to help make available a GPS (global positioning system) guidance tracking system for spray aircraft. In aerial spraying it is important to apply pesticide as accurately as possible in order to improve its efficiency and thereby reduce costs and the impact on the environment. It is also important to know aircraft location in real-time and to have a permanent record of its flight patterns. Therefore, some type of guidance/tracking system is necessary. A guidance system is needed to assist the pilot in the precise application of the material and a tracking system is needed to provide a record of where the aircraft flew for post-flight analysis of the operation. These records could also be input into GIS. In the post analysis of the operation, skips can be determined and respray performed.

Background

In the past Loran-C and many other systems have been looked at for use as guidance tracking system for spray aircraft. Most were found unsuitable for a variety of reasons including cost, terrain obstacles interfering with the signal, accuracy, etc. However, the Department of Defense's Global Positioning System (GPS) offers accuracy of better than 5m. This technology is capable of providing tracking and guidance information, and can be entered as a GIS overlay. These systems have application in many other areas such as photogrammetry, aerial surveys, remote sensing, etc.

Justification

This project has been given high priority by FPM National Steering Committees. The quality of aerial spraying depends primarily on obtaining complete coverage of the target area with the desired dosage of material. This is generally accomplished by swathing, and it is up to the pilot to assure that each flight path is so spaced that no skips or over spray exist between swaths. Maintaining this spacing in mountainous terrain is a difficult task.

Activity Schedule

Project Actions

1. Conduct evaluation and demonstration of GPS based aircraft guidance and navigation equipment in complex terrain.

2. Prepare a comprehensive report of FS experience and evaluation results.

3. Keep abreast of this technology, maintain expertise, and provide assistance in the field.

Schedule of Deliverables

FY95 - Comprehensive report on FS experience and results of instrument evaluations. Maintain contact with forestry users of GPS technology and monitor needs and operational methods.

FY96 - Technical paper in peer review or trade journal.

F. THERMAL INSECT CONTROL - 3E32P11

Description

The objective is to kill insect larvae in seed orchards before they emerge from the cones or from the duff layer. It has been shown that this is an opportune time in the insect's life cycle to rid the orchard, or at least lesson the impact, of the insect.

Background

Historically, prescribed fire has been found effective in control of seed and cone larvae but ideal burning conditions do not always occur prior to emergence. If the insect emerges during the rainy season, prescribed fire is useless because it will not propagate through the orchard. It is speculated that a piece of equipment can be adapted or developed to allow for the control of seed cone and duff layer pests during their vulnerable larvae stage. The exact temperature and duration of heat required to kill different pests may vary and needs to be determined.

Justification

This project was given priority by FPM National Steering Committees. This approach could offer a non-chemical, relatively economical method to control insects in seed orchards, consistent with USDA goals to reduce use of chemical pesticides.

Activity Schedule

Project Actions

1. Obtain equipment and conduct field evaluations with selected cooperators.

2. Modify equipment based on field evaluations if necessary, retest if necessary.

3. Produce report making recommendations as to feasibility of this approach and suggestions for advancement of the hardware technology.

Schedule of Deliverables

FY96 - Final Report.

G. Stationary Tree Sprayers -

Description

In certain high value seed trees, it may be economically feasible to install a semi-permanent sprinkler system to apply pesticide. High value seed is often collected in wild stands, however insects often destroy most of the crop. For environmental and economic reasons it is not feasible to treat these trees by traditional methods. Therefore, Nancy Rappaport, PSW, proposed a single tree system that could be "hard wired" to selected trees in both wild stands and orchards. A tank of material can be hooked directly to the single tree system.

Background

This system was first deployed as a special project by MTDC in cooperation with PSW to combat cone insects in sugar pine. Certain white pine trees have shown resistance to blister rust; therefore, the cones of these specific trees are very valuable. Since the initial use of this type of system, a second set of prototype systems are being tested in a seed orchard in Idaho.

Justification

This project originally began with a direct request from the field and has since been prioritized by FPM National Steering Committees. This method is well suited to single, high value targets and trees where many repeat applications are necessary. It also minimizes the amount of material applied by putting it directly on the target. There is growing interest in this technology.

Activity Schedule

Project Actions

1. To complete testing of prototype systems in California and Idaho as well as hardware stress testing at these locations and in Montana.

2. To prepare a summary report of performance and limitations

3. Design a detailed test plan.

4. Conduct detailed system trials.

5. Prepare report on field trials.

6. Continue to provide technology transfer for these systems within the FS and its cooperators.

Schedule of Deliverables

FY95 - Summary Report of preliminary field trials with engineering specifications and drawings of prototype spray systems.

FY96 - Detailed Test Plan for system evaluation trials.

FY97 - Summary Report and Conclusions based on all previous work.

H. COMPUTER ASSISTED SKETCH-MAPPING

Description

The advent of GPS positioning and high speed computer based GIS systems is influencing many established, hard map based procedures. In forest health aerial survey work, it may be feasible to replace hand marking of topographic maps with data entry into a GIS system which scrolls based on input from a GPS unit. This type of moving map display exists but the logistical considerations involved in integrating, installing and operating this type of airborne system are substantial.

Background

Currently, FPM conducts an aerial survey of most of the National Forest land annually and compiles statistics relating to infestation and general forest health. The current method is to fly at low altitude with a pilot and a FPM specialist who marks directly onto a paper map. In Region 1, the correct location on the map is generally found using drainages. Region 6 uses a regular flight path and a map grid to determine the map location. GPS and GIS technology combined now offer a possible alternative which would eliminate dependency upon specialist skills and the step of reducing map data after the survey flight. Spatial statistics and graphics could be produced directly from the GIS. The GPS interface would also improve survey accuracy in areas where the surveyor does not have topographical or other features to determine accurate map location.

Justification

This project was initiated directly by the Regions. This technology will allow the aerial survey sketchmapping to be done more efficiently and we believe with increased accuracy. The computer file which is produced should download directly to FS 615 systems or equivalent.

Activity Schedule

Project Actions

1. Define the procedure as currently performed by contacting FPM aerial survey specialists.

2. Survey manufacturers for applicable off the shelf systems. Possible candidates would be in photogeology, law enforcement, urban mapping, wildlife management etc. Find out if similar systems exist elsewhere in the FS.

3. Develop an integrated prototype system. The system will have a moving map display tied to a GPS positioner. It will allow easy data entry (probably mouse or touch input). It will pass any and all FAA requirements for use in an aircraft and will be easy to install.

4. Evaluate the system in actual use. This will involve test flying the system.

5. Prepare a summary performance report.

6. Support implementation of this technology in the FS.

Schedule of Deliverables

FY95 - Survey of Existing Systems

FY96 - Prototype System

I. ATMOSPHERIC CONDITIONS AND PESTICIDE DRIFT

Description

As concern increases regarding drift and accountancy of pesticides in the environment, focus is being shifted toward the small amount of material that becomes entrained in the ambient atmosphere and moves significant distances away from the intended target. This off-target movement or drift is largely controlled by ambient meteorological conditions. Though the primary effects of variables such as wind direction and speed are apparent, less intuitive effects due to temperature gradients (stability), humidity, solar radiation and other variables can have order of magnitude effects on the amount of off-target drift in certain situations.

Background

The study of these effects has been on-going under the Technical Services Project. As more sophistication is required of our drift modeling techniques, it is necessary to focus resources on these questions and determine the importance of the various meteorological factors.

Justification

The National Spray Model and Application Technology Steering Committee has established a sub-committee to deal with meteorological factors in pesticide spray operations. The sub-committee recommends that a better understanding of meteorological influences on pesticide drift is an effective mitigation measure. These recommendations are intertwined in Recommendations 1, 3 and 6 (FPM 94-15, 1994). The outcome of this work will be improved modeling and quantitative techniques as well as better training and technology transfer of drift mitigation measures.

Activity Schedule

Project Action

1. Prepare a report based upon an extensive literature review of DOD work and the peer review literature. Write a review journal article for ASAE on the nature of atmospheric stability and the relation between atmospheric stability and dispersion.

2. Conduct a controlled dispersion field test to demonstrate the role of atmospheric stability in pesticide drift, and publish data.

3. Complete meteorological guidance document for pesticide applicators.

4. Identify role and importance of monitoring various atmospheric variables in different situations for the purpose of managing drift.

5. Continue training of applicators and others in the importance of atmospheric variables.

Schedule of Deliverables

FY95 - Meteorological Guidance Document.

FY96 - Field Trial Design and Conduct Field Test.

FY97 - Stability Review Article.

FY98 - Publish Results of Field Trials.

J. PESTICIDE DRIFT IN COMPLEX TERRAIN

Description

The drift of pesticides in complex terrain presents a special set of problems due to topography, vegetation, and environmental concerns. Lateral dispersion is typically restricted by mountain or valley sides while downwind dispersion of pesticides in the atmosphere is typically enhanced by the prevailing wind fields in mountain valleys. The problem is to develop or adapt a model which will allow planning and analysis of aerial spraying operations in complex terrain.

Background

FS contracted with DOE-Battelle Pacific Northwest Laboratories (PNL) to develop an atmospheric dispersion model appropriate for use in pesticide application in mountain valleys. PNL provided the ValDrift model to the FS. Currently, the model is a stand alone FORTRAN model and work has begun (Thistle et al., 1994) to interface the ValDrift model to the FSCBG pesticide dispersion model.

Justification

The National Spray Model and Application Technology Steering Committee recommends the pursuit of this work under Recommendation 7 (FPM 94-15). Since a large part of the land which the FS manages is mountainous, drift of pesticide in these situations is a relevant and important issue. Understanding of drift in complex terrain and improvement of existing models and planning tools allows better planning, technology transfer and applicator training in drift mitigation. Cooperators also are eager to obtain this model.

Activity Schedule

Project Actions

1. Incorporate the ValDrift model into the FSCBG modeling system.

2. Validate ValDrift on existing complex terrain pesticide drift data.

3. Collect a complex terrain pesticide drift data set in an operational environment and use these data to validate ValDrift.

4. Prepare a journal article describing the ValDrift validation work.

5. Review advances in the study of complex terrain atmospheric dispersion as well as the atmospheric transport of aerosol clouds.

Schedule of Deliverables

FY95 - ValDrift incorporated into FSCBG.

FY97 - Journal article describing ValDrift performance against existing and collected data sets.

FY98 - FSCBG with ValDrift incorporated at the operational level including detailed user instruction.

K. VEGETATIVE CANOPIES AND PESTICIDE DRIFT

Description

Plant canopies are often the target of pesticide application either directly or through their role as food source or habitat for destructive insects. The ambient environment in and near the plant canopy can influence the efficacy of the application. The objective of this project is to review and evaluate the state-of-the-art in understanding the ambient environment and micro-meteorology inside plant canopies and to determine which variables are important and which are not in predicting in-canopy spray behavior.

Background

The study of in-canopy environment and micro-meteorology represents an entire sub-field of environmental science. Due to the complexity of the interactions in these environments, ambient monitoring is difficult and expensive. Scientists in the field are often absorbed by the problems of instrumentation and sorting out complex physical interactions, causing the literature, though extensive, to be difficult to use operationally. This problem has been pursued to some degree under Technical Services in the previous plan.

In applying material to a plant canopy, the top leaves of the canopy often receive the deposition while interior and lower leaves may have received little of the spray material. In other situations, the problem may be that excessive material ends up on the surface of the ground instead of the canopy. These concerns may be addressed by adjusting drop size, but drop size is dynamic and evaporation and drift will be influenced by the ambient environment in and near the canopy.

Justification

This study is a result of Recommendations 1, 2, 4, 5, and 6 of the National Spray Model and Application Technology Steering Committee. This study is critical to the correct determination of pesticide accountancy and fate in the ambient environment.

Activity Schedule

Project Actions

1. Conduct a detailed literature review of in-canopy deposition in conjunction with relevant atmospheric data. Conduct literature review of forest edge and shelterbelt micro-meteorology.

2. Publish report on in-canopy micro-meteorology.

3. Design a detailed study to associate in-canopy fate of pesticide with relevant in-canopy environmental variables.

4. Update the FSCBG modeling system to reflect the relationship between in-canopy meteorology and pesticide fate predictions.

Schedule of Deliverables

FY95 - Peer review journal article or FS report discussing in-canopy micro-meteorology.

FY96 - Experimental design of a study to determine the relationship between in-canopy deposition and in-canopy meteorology.

FY98 - FSCBG update incorporating in-canopy micro-meteorology.

L. NON-CHEMICAL ORCHARD SANITATION

Description

Non-chemical orchard sanitation techniques such as sweeping and steaming may be safe, effective means of eliminating certain pests from seed orchards. Infestations such as cone beetle have a substantial economic impact on FS seed orchards and orchard managers are searching for non-chemical methods to combat these pests.

Justification

The Non-chemical Orchard Sanitation project addresses needs reported in the National Steering Committee for Management of Seed, Cone, and Regeneration Insects (FPM 93-13). As costs associated with the use of chemical pesticides increase, orchard managers are left with fewer and fewer tools to combat economically important pests. This project will provide managers with safe, efficacious, and economically feasible tools to combat pests in seed orchards.

Activity Schedule

Project Actions

1. To follow-up on equipment leads that were developed under the Thermal Insect Control Project. The most promising equipment for control of cone insects on the orchard floor is sweeper or vacuum collection technology. Other potentially useful technology includes steaming and ultrasound.

2. To perform field trials on potentially useful equipment with success being based on safety, efficacy, economics, and practicality.

3. To prepare a report summarizing this technology and making recommendations which will vary based on biological and regional considerations.

Schedule of Deliverables

FY95 -

FY96 - An intermediate report identifying and discussing potential alternatives.

FY97 - An report on field trials of most promising alternatives.

FY98 - An report making recommendations regarding orchard sanitation equipment.

V. SUMMARY

The MTDC/FPM 5-Year Program was developed jointly by MTDC and WO/FPM at the request of Director of FPM and manager of MTDC. It addresses technical needs identified by FPM's National Steering Committees and other field cooperators. The Plan shows projected project costs over a 5-year period, outlines a management and annual review process and emphasizes the role of the Field sponsors as participants. The Plan maintains flexibility, as is necessary in any developmental activity, and provides for project review, modification, and cancellation. No project will be assigned to or accepted by MTDC without a high probability of achieving success, staying within project costs, and delivering on schedule. Comments and guidance are continually welcome.

APPENDICES

A. DEFINITIONS

Field Sponsor	A FS professional or cooperator who has an interest in the project and works with the MTDC Project Leader through project technology transfer.
FPM National Steering Committees	National committees that identify needs, set priorities, and make recommendations for technology development to Director, FPM.
Engineering FS - T&D Program	The technology and development program at Missoula (MTDC) and San Dimas (SDTDC) Technology and Development Centers that includes FPM projects.
FPM Sponsor/Coordinator	WO/FPM staff person who represents the Director, FPM in coordinating and monitoring the MTDC/FPM projects. Currently this person is Jack Barry.
FPM Technology Development Program	A program established by Director, FPM to administer and manage the FPM Technology Development Program. This program is distinct and separate from the Engineering FS-T&D (Technology and Development Program).
MTDC/FPM 5-Year Plan	A document that contains the projects, project plan outlines, and budget estimates of 1 or more FPM sponsored projects; and is managed and updated annually by MTDC/FPM.
Project Leader	MTDC project person assigned to the project by the Center Management.
Project Proposal	A brief document (1-4 pages) that describes the objective, cooperators, what, when, where, why, how, and cost of the proposed project.

Project Work Plan	A detailed plan, on how the Project Leader plans to approach the total project to include responsibilities, cost estimate, and event schedule.
Program Leader	MTDC staff person who represents Manager, MTDC in coordinating and monitoring the MTDC/FPM Program and projects. Currently this person is Harold Thistle.
Technology Transfer	An activity that begins at inception of the project and continues throughout the project until completed.

B. ACCOMPLISHMENTS

MISSOULA TECHNOLOGY AND DEVELOPMENT CENTER

ANNUAL REPORT

FY 93 AND FY 94 ACCOMPLISHMENT

FOREST PEST MANAGEMENT PROGRAM

Missoula Technology and Development Center (MTDC) and Forest Pest Management (FPM) developed a Five-Year program Work Plan (Plan) that was approved by Director, Forest Pest Management in FY 92. Work began under this plan upon receipt of FY 93 funds. The Plan outlines six specific projects plus a general project for technical services. The Plan has been useful to both MTDC and FPM in program management and gauging success. At the end of each fiscal year the Plan will be updated and an accomplishment report prepared. Questions and comments are encouraged and should be directed to Harold Thistle (MTDC), (406)329-3981; to Jack Barry (WO/FPM), (916)758-4600; or to the project leaders listed under each project.

United States
Department of
Agriculture

Forest Service

MTDC
Missoula, MT

MISSOULA TECHNOLOGY AND DEVELOPMENT CENTER

FOREST PEST MANAGEMENT PROGRAM

ANNUAL REPORT -

FY 93 AND FY 94 ACCOMPLISHMENTS

Appendix to FPM 94-16
September 1994

Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

Appendix to
FPM 94-16
September 1994

Missoula Technology and Development Center - Annual Report FY 93 and FY 94 Accomplishments Forest Pest Management Program

Prepared by:

Harold Thistle
Title: Project Leader

Missoula Technology and
Development Center
Missoula, MT 59801

USDA Forest Service
Forest Pest Management
2121C Second Street
Davis, CA 95616
(916)758-4600

John W. Barry
FPM Sponsor/Coordinator

MISSOULA TECHNOLOGY AND DEVELOPMENT CENTER

ANNUAL REPORT

FY 93 AND FY 94 ACCOMPLISHMENTS

FOREST PEST MANAGEMENT PROGRAM

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I. THERMAL INSECT CONTROL

Project Leader -
Keith Windell (406)329-3956

Project Description

The objective is to kill insect larvae in seed orchards before they emerge from the cones or from the duff layer. It has been shown that this is an opportune time in the insect's life cycle to rid the orchard or at least lesson the effect of the insect.

Background

Historically, prescribed fire has been found effective in killing larvae but ideal burning conditions do not always occur prior to emergence. If the insect emerges during the rainy season, prescribed fire is useless because it will not propagate through the orchard. It is speculated that a piece of equipment can be adapted or developed to allow for the control of seed cone and duff layer pests during their vulnerable larvae stage. The exact temperature and duration of heat required to kill different pests may vary and needs to be determined.

1. ACTION:

Develop contacts with people knowledgeable in the seed orchard pest management field in preparation for subsequent project work.

ACCOMPLISHMENTS - FY 93: The project leader has contacted experts and manufacturers regarding thermal insect control techniques and experience. MTDC learned of two equipment evaluations which are being conducted in FY 94 and is planning to attend both of these and participate as required. The first is being conducted by FPM in Region 9 and will focus on exterminating pests inside fallen cones. The second is being conducted by FPM Region 6 in cooperation with Oregon State University and is focused on killing insects in the duff layer.

ACCOMPLISHMENTS - FY 94: The project leader contacted experts and manufacturers regarding thermal insect control experiences and techniques. A literature search was conducted. The project leader attended and participated in two different equipment evaluations and submitted trip reports to the sponsor. One trip was to the Beaver Creek Seed Orchard (Oregon) to observe the effectiveness of a prototype field burner for killing Douglas-fir cone gall midges in the duff layer. Cooperators in the test included FPM (R6 - Portland), Oregon State University (Corvallis), and orchard personnel. The other trip was to the Oconto River Seed Orchard (Wisconsin) to observe the effectiveness of a commercial agricultural weed burner in killing white pine cone beetle larvae while they are overwintering in the

cones. Cooperators in the test included FPM (NA S&PF - St. Paul, MN) and orchard personnel. Since trials at both orchards were not completely successful alternative concepts were developed. A market search was conducted to determine price and availability of equipment for concepts. A progress report for FY 94 activities was generated and submitted to the sponsor. A short DG survey is in the process of being distributed to federal seed orchards to determine, among other things, what budget constraints for alternative concepts must be taken into account.

Reference: **Windell, K. 1994. FY 94 - Progress report - Thermal insect control. TA&S #4E32P11. USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.**

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

Project Description

The objective is to provide prompt technical services on request, and to coordinate program planning support to the sponsoring Washington Office unit. At the request of the Forest Pest Management Staff, the Center conducts special investigations and studies; participates in field programs; evaluates employee suggestions;contacts field personnel to determine instrumentation and equipment needs; delivers presentations on Forest Pest Management methods at training sessions, meetings, and workshops;
provides follow-up services on completed development projects and answers requests for information from field units, Government Agencies, and industry; publishes reports; prepares manuscripts for journal publications; and handles program planning and Washington Office coordinator activities for Forest Insect and Disease Management projects at the Center.

Background

MTDC represents a unique resource of people, knowledge, professional and technical skills, and is the only source of mechanical and electrical engineers in the Forest Service other than those in Research. Historically, FPM has called upon MTDC for immediate and short term professional judgements, on-site support, contract specifications, equipment evaluations, drafting, editing, publication, and assistance in Technology Transfer activities. Need for these services will, at a minimum, continue at current levels and likely will increase.

1. ACTION:

Perform technology transfer through attendance of national meetings and workshops, presentation of papers, and preparation of manuscripts for journal publications.

ACCOMPLISHMENTS - FY 93:

Technical Meeting Presentations

Touma, J.S., W.M. Cox, and H.W. Thistle. 1993. Statistical analysis of the performance of dense gas dispersion models. Presented at *american meteorological society, air and waste management association - the role of meteorology in managing the environment.* Scottsdale, AZ, January, 1993.

Thistle, H.W., M.E. Teske, and J.W. Barry. 1993. The relationship between in-canopy micrometeorology and droplet deposition. Presented at *1993 international summer meeting, american society of agricultural engineers and canadian society*

of agricultural engineers. Spokane, WA, 20-23 June.

Thistle, H.W., J.W. Barry, and M.E. Teske. 1993. Development and validation of the FSCBG model for the simulation of spray drift. Presented at the *second international symposium on pesticide application techniques.* Strasbourg, France. September, 1993.

Journal Articles

Two articles tentatively accepted into the *Journal of Environmental Engineering.* One article in preparation for the *Journal of Agricultural and Forest Meteorology.*

ACCOMPLISHMENTS - FY 94:

Technical Meeting Presentations

Thistle, H.W., J.W. Barry, and M.E. Teske. 1993. Computing total accountancy of aerially released material. Presented as a poster at *society of environmental toxicology and chemistry 14th annual meeting - ecological risk assessment: lessons learned?* Houston, TX, 14-18 November.

Thistle, H.W., M.E. Teske, and J.W. Barry. 1994. Penetration of aerially released material into forest canopies: A review of early work. Presented at *ASAE 1994 international summer meeting.* Kansas City, MO, 19-22 June.

Teske, M.E., J.W. Barry, and H.W. Thistle. 1994. Environmental fate and accountancy. Presented at *ACS symposium - biorational pest control agents: formulation and delivery.* San Diego, CA, 16-17 March.

Peer Reviewed Journals and Books

Thistle, H.W., D.R. Murray, M.R. Ratte, and M.R. Carroll. 1994. Atmospheric tracer concentrations from an elevated source in an urban core. *Journal of Environmental Engineering* (In Press).

Thistle, H.W., D.R. Murray, M.R. Ratte, and M.R. Carroll. 1994. Observed downwash concentrations compared to ISCST predictions in an urban core. *Journal of Environmental Engineering* (In Press).

Teske, M.E., J.W. Barry, and H.W. Thistle. 1994. Aerial spray drift modeling. In *Environmental Modeling Vol. II: Computer Methods and Software for Simulating Environmental Pollution and Its Adverse Effects*, ed. P. Zannetti, 11-42. Southhampton: Computational Mechanics Publications.

Touma, J.S., W.M. Cox, H.W. Thistle, and J.G. Zapert. 1994. Performance evaluation of dense gas dispersion models. *Journal of Applied Meteorology* (In Press).

Thistle, H.W., D.R. Miller, and J.D. Lin. 1994. The wind flow field through a forest edge: A comparison of foliated and unfoliated canopies. Submitted to *Journal of Agricultural and Forest Meteorology*.

Training Activities

MTDC ran training of four courses, meetings, or symposiums.

National Agricultural Aviators Association. Harold Thistle spoke on the role of meteorology in spray dispersion. Reno, NV, December 1993.

Workshop on Spray Drift Management - Can Computer Models Help? Harold Thistle spoke on the validation of computer models. Rotorua, NZ, February 1994.

National Pesticide Use Management Course. Five MTDC engineers and scientists gave lectures and presentations on topics ranging from spray physics to pump design. Marana, AZ, March 1994.

U.S. Department of Defense Aerial Application of Pesticides Certification Course. Harold Thistle spoke on the role of meteorology in spray dispersion. Youngstown, OH, June 1994.

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

2. ACTION:

Act timely on routine requests and inquiries; including publishing, illustrating, and photographic support.

ACCOMPLISHMENTS - FY 93: MTDC has designated publication and photographic personnel to support project objectives. These services are routinely available to the FPM project leaders. Specific efforts this FY included full photographic support of the Region 4 Utah gypsy moth eradication project. MTDC also has publication staff to handle routine requests for publications. The project leader handles technical questions on a daily basis.

ACCOMPLISHMENTS - FY 94: MTDC/FPM publication and photographic personnel were used to develop photo-ready manuscripts for the above-mentioned journal articles. The photographic support was used to develop slide shows for the various training courses. Requests were also made directly from the FPM sponsor and FPM regional personnel which were completed.

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

3. ACTION:

Provide meteorological measurement and consultation to support FPM field projects.

ACCOMPLISHMENTS - FY 93: Provided meteorological support including three baseline met towers, a ridgetop station and various special projects in the Wasatch Front as part of *Bacillus thuringiensis* - Drift/Dispersion and Effects on Non-Target Lepidoptera, Utah 1993 - Phase III.

Provided meteorological instrumentation in support of Gypsy Moth Larvae Survival Study sponsored by the State of Utah and Region 4. The meteorological data were used in go/no-go decisions by the Region 4 staff. The data were archived for later use in spray drift model validation.

ACCOMPLISHMENTS - FY 94: Provided meteorological support to the Peach Twig Borer Study, February 1994, in Chico, CA. This study involved transfer of Forest Service aerial application technology to agriculture using a biological insecticide. Provided meteorological support to Region 4 background gypsy moth monitoring work July-August 1994. Provided meteorological support to the second year of the Gypsy Moth Larvae Survival Study run by the State of Utah and Region 4.

Harold Thistle serves as chairperson of the Meteorological Sub-committee of the USDA-FS National Spray Model and Application Technology Steering Committee. The sub-committee has prepared a draft document on meteorological measurements necessary for computer modeling of aerial spraying.

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

4. ACTION:

Coordinate MTDC project capabilities with requests from Regions, Stations, NA, WO, and FPM units.

ACCOMPLISHMENTS - FY 93: MTDC attended national steering committee meetings for Seed and Cone Insects, Western Defoliators, Gypsy Moth and Eastern Defoliators, and Spray Model and Advisory. In this way the Center keeps in touch with developments and needs Forest Service wide. The FPM program works frequently with personnel from all regions. We currently have cooperative efforts with Region 4 and Region 6. We are in frequent touch with personnel from Regions 1, 8, and 9. We are responsive to suggestions and needs of FPM units nationwide.

ACCOMPLISHMENTS - FY 94: MTDC attended steering committee meetings for the Spray Model and Application Technology Committee, Western Defoliators, and Seed and Cone Insects. Harold Thistle has attended meetings with other units at the National Forest Health Center in Morgantown, WV and the Plant Insect and Disease Laboratory in Hamden, CT. We have worked this FY with FS personnel in CA, UT, ID, CT, WV, OR, MT, WI, MI, AR, NC, SC, and others. MTDC has also established substantive contacts with USDA-APHIS and USDA-ARS.

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

5. ACTION:

Complete reports for terminated projects and status reports.

ACCOMPLISHMENTS - FY 93: A first draft of the report on the Block Marking Project was completed in October 1993. Trip reports are prepared and filed on a regular basis, and are available on request.

ACCOMPLISHMENTS - FY 94: The Block Marking Report is in press and the project is completed.

II. TECHNICAL SERVICES

Project Leader -
Harold Thistle (406)329-3981

6. ACTION:

Initiate new projects as directed by FPM/WO (assignments subject to revision as needs change).

ACCOMPLISHMENTS - FY 93: MTDC responded to a request from WO/FPM to design a system for a stationary sprayer to do single-tree spraying in response to an FPM need to protect rust-resistant sugar pine cones. MTDC cooperated with FPM, Sierra National Forest, and PSW on this project and performed a preliminary field evaluation in central California. Preliminary results are promising and the system performed as designed. Testing by Sierra National Forest is continuing.

ACCOMPLISHMENTS - FY 94: MTDC has responded to a request from R-6 to investigate systems to computerize the regional forest health inventory which is currently done through a manual sketchmapping approach. MTDC has attended a system demonstration that has system capabilities very close to those desired. Preliminary investigation indicates that the desired technology is available but will probably take some customization and integration.

III. TECHNICAL TRANSFER OF COMPUTER MODELS

Project Leader -
Harold Thistle (406)329-3981

Project Description

The objective of this project is to support the technical transfer of models that support the safe and effective application of pesticides. Mathematical models have been developed that use descriptions of meteorological processes and descriptions of the application methods and equipment to simulate dispersion and deposition of airborne materials. Analysis of data is on-going and models have been improved and verified based on field trials. Training in the use of the models began in FY 1988 and will continue as the models evolve and become more sophisticated. In FY 95, a complex terrain dispersion model will be incorporated into the FS system of models.

Background

MTDC has played an integral role in the development of the FS spray dispersion models. The modeling system currently in use (FSCBG) consists of two basic model types with a third to be added this year. The far-field model is Gaussian and has been adopted from U.S. Army models. The near field model is a LaGrangian transport model which has been developed under contract to the FS, the third and newest part is a phenomenological model describing transport in complex terrain. Both the near field and the complex terrain models have been developed under contracts overseen through MTDC.

1. ACTION:

Continue to provide support for systems management and implementation of existing spray and other models plus support the introduction and application of new models to users.

ACCOMPLISHMENTS - FY 93: The pesticide spray droplet evaporation study was completed in FY 93 and a final report was received in June. The results for water were tested against the model and the agreement was very good. Results for BT will be used to upgrade the FSCBG model. The complex terrain field and model work continued in FY 93. The VALDrift module for simulating pesticide flow in mountain valleys is being developed by Battelle Pacific Northwest Laboratories under USDA-FS sponsorship. The module has been written and is currently in the process of being tested against existing data gathered in R-4. There are numerous other model development tasks which are undertaken at the behest of the various FPM steering committees, based on other user concerns, or due to model performance questions raised by validation tests. Among those being considered is a full evaluation of the in-canopy treatment in the model and a full evaluation of the source algorithm.

ACCOMPLISHMENTS - FY 94: Harold Thistle of MTDC participated in a workshop in Rotorua New Zealand with the goal of exchanging information with New Zealand users of USDA Forest Service spray dispersion models. This was a very informative exchange.

MTDC received the VALDrift model from Battelle - Pacific Northwest Laboratories. This model will be incorporated into the FSCBG system of models and allows a more realistic simulation of atmospheric dispersion and deposition in complex terrain. A substantial effort will be conducted in the coming year to interface this model into FSCBG. Other model development efforts involve introduction of a ground sprayer model in the FSCBG system as well as an edge model that could handle dispersion near windbreaks, woodlots, and forest edges. A further focus is to develop a simplified drift model which could be used in conjunction with a GPS positioning system as an on-board alarm to notify a spray pilot that off-target drift may be exceeding a threshold limit.

IV. BLOCK MARKING METHODS GUIDE

Project Leader -
Harold Thistle (406)329-3981

Project Description

The objectives are to assemble practical information and publish a guide on methods of marking areas to be aerially treated with pesticides. A guide needs to be published describing each method, the equipment, and the advantages and disadvantages of each. The cost of each device as well as the actual cost of marking needs to be included. Marking procedures should also be analyzed to consider and evaluate safety, and the effects of differences in vegetation, composition, and structure also need to be considered.

1. ACTION:

Develop a Total Project Work Plan for sponsor review.

ACCOMPLISHMENTS - FY 93: This task was only on the five-year plan in FY 93. WO/FPM indicated that the deliverable document should be a short summary report which in many ways updates previous MTDC work.

IV. BLOCK MARKING METHODS GUIDE

Project Leader -
Harold Thistle (406)329-3981

2. ACTION:

Contact key specialists and assemble pertinent information for block marking methods.

ACCOMPLISHMENTS - FY 93: A summary document of contacts and relevant comments has been produced and will be paraphrased and included in the final report. Contacts were made in most Forest Service regions, APHIS, academia, and private industry.

IV. BLOCK MARKING METHODS GUIDE

Project Leader -
Harold Thistle (406)329-3981

3. ACTION:

Conduct market literature search and through appropriate contacts, establish an outline for the guide. Conduct appropriate analysis for systems and methods.

ACCOMPLISHMENTS - FY 93: The guide will consist of a discussion of available methods and advantages/disadvantages of the various methods based on discussion with experts. Manufacturers will be listed where appropriate, although based on discussions to date, some of the methods currently used are based upon generic component materials (safety orange sheet cloth, for example) which is fashioned by the user.

IV. BLOCK MARKING METHODS GUIDE

Project Leader -
Harold Thistle (406)329-3981

4. ACTION:

Prepare memo reporting on findings and future actions.

ACCOMPLISHMENTS - FY 93: A detailed document will be available in draft form by the end of October 1993. The document discusses current techniques and will recommend that most of this work can now be done using GPS technology. Certain special applications may require traditional block marking methods.

ACCOMPLISHMENTS - FY 94: Completed (Report is in Press).

V. GROUND AND AERIAL PHEROMONE APPLICATOR EVALUATION

Project Leader -
Diane Herzberg (406)329-3957

Project Description

The overall objective is to help make available equipment and procedures for applying pheromones both aerially and on the ground. Methods and equipment need to be investigated, evaluated, and possibly developed for dispersing pheromones in tubes, capsules, flakes, pellets and granules. Investigate solid dispersal systems, how pheromones are currently dispersed, and in what forms they can be obtained. Included is the necessary familiarization and training in related software and test procedures, as well as planning and coordination. Field testing will be accomplished, hardware modified if necessary, and progress documented.

Background

Pheromones are chemical substances released by animals and insects, and provide an odor that becomes a means of communication between species. The release of pheromones is sometimes used to establish territories, provide a warning mechanism, or to attract other members of the same species. Pheromones are usually gaseous in the natural state. These pheromones can be produced synthetically and can be used to cause communications disruption between the insects or used to warn the insects to leave the area. Because the pheromones are usually gaseous, there has to be a mechanism built into the synthetic product to allow controlled release over a period of time. The time release mechanism is accomplished by encapsulating the pheromones in plastic polymers that will break down over time. The end product can be packaged in many forms, from plastic granules to spaghetti like tubes or strings and are aerially applied with adapted granule applicators or manually placed in the treatment area.

1. ACTION:

Develop contacts with people knowledgeable in the pheromone application field in preparation for subsequent project work.

ACCOMPLISHMENTS - FY 93: Numerous contacts have been made in the field of pheromone application technology including experts from USDA-FS, APHIS, and the private sector. MTDC plans to participate in equipment evaluation in the coming year based on these contacts.

ACCOMPLISHMENTS - FY 94: Obtained literature and information from researchers and manufacturers on pheromone application techniques and studies.

Established contact and toured facilities of pheromone researchers at Simon-Fraser University. Established field contact with contract pheromone applicators to determine what equipment is being used to apply the pheromone dispensers. (K&K Aircraft, Harold Millers Flying Service.) Worked with Forest Service and ARS researchers along with APHIS and state agency personnel on experimental and Slow The Spread gypsy moth pheromone applications in Virginia and West Virginia.

Examined a bark beetle pheromone study being conducted by Region 1 entomologists. Examined traps and dispensers being used.

Established contact with several pheromone manufacturers: Pherotech, Inc.; Hercon Manufacturing; AgriSense; and Scentry. Conducted field trips to Hercon and Pherotech. Obtained sample dispensers and ground dispensing equipment from Hercon, Pherotech, and AgriSense.

V. GROUND AND AERIAL PHEROMONE APPLICATOR EVALUATION

Project Leader -
Diane Herzberg (406)329-3957

2. ACTION:

Prepare for and give presentation at March 1994, FPM training session in Arizona.

ACCOMPLISHMENTS - FY 94: Prepared and presented a 1-hour training course on ground and aerial pheromone application equipment and a 1/2 hour presentation on rotary atomizers.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

Project Description

The objective of this project is to make it possible to predict ground spray behavior by characterizing the spray plume, spray deposition, and spray drift from ground sprayers used in seed orchards, and then evaluating and modifying the FSCBG model system for use in predicting drift from ground application of pesticides.

Background

Computer models are used to predict the airborne drift of pesticides released from aircraft in aerial spraying. In order to utilize these models, it was necessary to first determine the characteristics of the aerial spray droplets. Nozzle and droplet distributions for ground applications differ from those of aerial applications. For modelling purposes, it is necessary to know the exit speed and angle of droplets exiting the nozzles. The FSCBG aerial spray model system was developed for aerial application of pesticides. It is widely used for that purpose and there are large groups of trained users. The near field model (AGDISP, LaGrangian transport model) has a ground application module, but it has never been validated. It is anticipated that the software will have to be modified based on the experimental data obtained.

1. ACTION:

Develop a total project work plan for sponsor review.

ACCOMPLISHMENTS - FY 93: The work plan is pending subject to receipt of an existing algorithm for performing this task. The work plan will be submitted within the next six months.

ACCOMPLISHMENTS - FY 94: A draft study plan has been written and has undergone one review. A final plan will be published in 1995.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

2. ACTION:

Survey ground spray equipment currently used in seed orchards. Select ground sprayers and configurations to characterize.

ACCOMPLISHMENTS - FY 93: Under direction of the sponsor, it has been decided to focus this task on air-blast sprayers. This type of sprayer utilizes a high velocity air-stream to transport the spray material. This type of sprayer is commonly used to treat orchards and more closely imitates aerial spraying than other ground sprayers but is also more susceptible to off-target drift. Sprayer configurations and models have not yet been determined.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

3. ACTION:

Identify objective for models, set criteria for evaluation, and develop evaluation protocols.

ACCOMPLISHMENTS - FY 93: An appropriate ground sprayer model has been identified and MTDC is in the process of obtaining this model. Final transfer arrangements will be made in September, 1993. Two separate model validation plans/protocols have been received at MTDC and these will be used to develop a USDA-FS protocol.

ACCOMPLISHMENTS - FY 94: This model was not received due to complications regarding ownership and the reluctance of the developer to release it. However, Spray Drift Task Force (SDTF) and US Environmental Protection Agency (EPA) have also been working on drift from ground sprayers and are developing a second model that will focus on drift as opposed to near field transport. The model is a random walk model and this type of model has not been received favorably by EPA. A draft study plan is in existence and preliminary ground trials have been run in New Zealand to assist model development and validation. We plan to conduct joint trials in New Zealand during 1995.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

4. ACTION:

Consult with and select one or more Regional cooperators for field evaluation.

ACCOMPLISHMENTS - FY 93: MTDC received ground sprayer validation protocols from Region 8 and the SDTF (the latter was under the conditions of peer review and is not to be directly copied). Ed Monnig of R-1 has been contacted with regard to two proposed ground sprayer validation projects and will likely cooperate in at least one.

ACCOMPLISHMENTS - FY 94: Cooperators have been chosen from the Forest Research Institute (FRI) in Rotorua, NZ and the Agricultural Engineering Institute (AEI) in Hamilton, NZ. This relationship was established because these groups were planning similar work and through cooperation with them the economics are such that FS can conduct a much more sound, significant set of characterization trials.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader - Harold Thistle (406)329-3981

5. ACTION:

Develop procedures and inputs for ground use of FSCBG and AgDISP aerial spray models.

ACCOMPLISHMENTS - FY 93: AgDISP can currently be used in ground sprayer mode, however, it is unvalidated. It is planned to perform testing in FY 94 of AgDISP interfaced into FSCBG. Subsequent to the receipt of the ground sprayer model from the UK, an analysis will be performed to determine how best to proceed and what additional FSCBG inputs will be required.

ACCOMPLISHMENTS - FY 94: It was decided that the model will be a stand alone source module in the FSCBG modeling system. Most of the inputs will be the same with the exception of the source menu which will be created to include specific types of ground sprayers. The setting up of the source will parallel what is currently done for airplanes.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

6. ACTION:

Select drift samplers and procedures for collecting and analyzing data.

ACCOMPLISHMENTS - FY 93: Two ground sprayer evaluations have been planned for FY 94. One would be a cooperative effort with the Forest Research Institute (FRI) in New Zealand. A detailed model evaluation protocol will be prepared and details will be negotiated with FRI. The details of the equipment which will be used will be largely determined by logistics, although a primary rationale for performing cooperative work with FRI is that they have certain resources not easily available in the U.S.

The second field evaluation which has been discussed is an evaluation to take place in northwestern Montana. Sampling details have not yet been decided, although the sampling program would probably rely on Rotorods and deposit cards with possible inclusion of a real time particle analyzer belonging to Dugway Proving Ground.

ACCOMPLISHMENTS - FY 94: This effort will now focus on cooperation with New Zealand's FRI and Agricultural Engineering Institute.

VI. CHARACTERIZING SPRAY FROM GROUND SPRAYERS

Project Leader -
Harold Thistle (406)329-3981

7. ACTION:

Conduct Field Trial.

ACCOMPLISHMENTS - FY 94: Field trials were conducted in April, May 1994 by AEI and FRI. The main trials are scheduled for May 1995. A draft test plan exists and a meeting was held between USDA-FS and New Zealand in Hamilton, NZ in January 1994 to begin discussing the logistics of the experimental design. Suggestions during that meeting were incorporated into the field trials conducted in May 1994.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

Project Description

The objective of this project is to help make available a guidance tracking system for spray aircraft. In aerial spraying it is important to apply pesticide as accurately as possible in order to improve its efficiency and thereby reduce costs and the impact on the environment. It is also important to know aircraft location in real-time and to have a permanent record of its flight patterns. Therefore, some type of guidance\tracking system is a must. A guidance system is needed to assist the pilot in the precise application of the material and a tracking system is needed to provide a record of where the aircraft flew for later analysis of the operation, or input into GIS for future information and possible future litigation. In the post analysis of the operation, skips can be determined and respray accomplished.

Background

In the past Loran-C and many other systems have been looked at for use as a guidance tracking system for spray aircraft. Most were found unsuitable for a variety of reasons including cost, terrain obstacles interfering with the signal, accuracy, etc. However, the Department of Defense's Global Positioning System (GPS) offers accuracy of better than 5m. This is capable of providing tracking and guidance information, and can be entered as a GIS overlay. These systems have application in many other areas such as photogrammetry, aerial surveys, remote sensing, etc.

1. ACTION:

Develop a total project work plan for sponsor review.

ACCOMPLISHMENTS - FY 93: A draft action plan will be to the sponsor for review by November 30, 1993.

ACCOMPLISHMENTS - FY 94: A test plan for the GPS Aircraft Guidance Evaluation/Demonstration has been prepared and distributed.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

2. ACTION:

Investigate current navigation equipment capabilities and limitations with Path Link and other systems (R-6, R-8, APHIS, MAG, USCG) and applicable applicators and manufacturers.

ACCOMPLISHMENTS - FY 93: MTDC has developed a large reference file of equipment manufacturers and has talked to numerous users of aerial guidance systems. USDA-FS and USDA-APHIS personnel have been contacted. MTDC is planning to participate in evaluations by academia, manufacturers, APHIS, and operators.

ACCOMPLISHMENTS - FY 94: MTDC staff attended four demonstrations at Puyallup, WA; Marana, AZ; Mio, MI, and Phoenix, AZ of GPS navigation/guidance systems in FY 94. William Kilroy of MTDC conducted a phone survey of FS and others involved in the actual use and operation of GPS navigation/guidance systems in FY 94 and an interim summary report based on these phone conversations and various reports prepared nationwide is being prepared. An announcement of FS intent to conduct an equipment demonstration in the Consumer Business Daily (CBD) turned up many companies interested in our demonstration.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

3. ACTION:

Conduct market search and interview users of all systems.

ACCOMPLISHMENTS - FY 93: A large file of manufacturers has been compiled and numerous contacts in government and industry have been made. MTDC personnel participated in an evaluation of GPS technology in aerial guidance in February 1993 at Las Cruces, NM. The GPS system performance was remarkable as APHIS pilots duplicated unmarked flight lines within 2 meters in the desert with few landmarks. A trip report was filed with the sponsor.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

4. ACTION:

Analyze the results of the investigation and interviews and issue a report.

ACCOMPLISHMENTS - FY 93: An analysis based on the previous work has led to the conclusion that GPS technology is the future in this area. There are still some important questions to be answered regarding selective interference by DOD and system performance in complex terrain.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

5. ACTION:

Summarize recommendations and alternatives.

ACCOMPLISHMENTS - FY 93: GPS technology should be pursued and integrated into control systems that will allow automated, accurate logging of position, optimize travel to loading zones, optimize coverage, and address various questions which can arise in litigation. All alternatives fall far short of the GPS capability. USDA-FS will monitor DOD policy with regard to this satellite network.

ACCOMPLISHMENTS - FY 94: An interim report is being prepared which will summarize FS experience in the FY 94 field season. MTDC has compiled a set of project reports from around the country which will be summarized. MTDC personnel have now witnessed demonstrations of systems by four manufacturers and these experiences will be included in the interim report. MTDC personnel have been invited to speak at two separate meetings to discuss findings regarding GPS navigation.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

6. ACTION:

Publish a reference/source book.

ACCOMPLISHMENTS - FY 93: MTDC has compiled extensive information regarding aerial guidance systems. However, the rapid evolution of this technology has made it impractical to "freeze it" at a point in time for inclusion in a book. Based on recent discussions with the sponsor, MTDC will pursue the creation of a source book based on current information in FY 94.

ACCOMPLISHMENTS - FY 94: MTDC will prepare a final project report which will include results and description of the evaluation/demonstration, the interim report and discussion/recommendations regarding equipment. This is the document which will be focused upon in FY 95. The reference/source book will be based on this document.

VII. AIRCRAFT GUIDANCE

Project Leader -
Harold Thistle (406)329-3981

7. ACTION:

Proceed with field testing and evaluation based on above recommendations, including implementing and documentation as appropriate.

ACCOMPLISHMENTS - FY 94: MTDC is conducting field testing on the Nine-mile Ranger District in October 1994. This is both a test and a demonstration for FS personnel and others interested in this technology. Over 125 notifications have been sent to potential observers and three GPS navigation equipment manufacturers will participate. These tests will be thoroughly documented and reported upon.

VIII. SINGLE TREE APPLICATORS

Project Leader -
Diane Herzberg (406)329-3957

Project Description

The objective of this project is to design and produce an inexpensive semi-permanent spray system to install in high value trees for the purpose of applying repeated spray treatments. In certain valuable seed trees, it may be economically feasible to install a semi-permanent sprinkler system to apply pesticide. By 'hard-wiring' to the tree of interest, off target material and drift can be minimized. In correctly designed systems, a tank of material would be hooked directly into the single tree system and pumped out the sprinkler which is near the top of the tree.

Background

This system was first deployed as a special project by MTDC in cooperation with PSW to combat cone insects in white pine. Certain white pine trees have shown resistance to blister rust. Therefore, the cones of these specific trees are very valuable. Since these rust resistant trees are widely dispersed in the Sierra Nevadas, it is not feasible to perform a wide area application when only single trees are the targets. Since this initial use of this type of system, a second set of prototype systems are being tested in a seed orchard in Idaho.

ACTION:

Initiate formal project, continue CA testing and initiate further trials of single-tree applicator.

ACCOMPLISHMENTS - FY 94: Worked with the Coeur d'Alene Nursery to develop a study to compare a single-tree spray system with the hydraulic sprayer system the nursery currently uses to apply pesticides. Ten systems were installed in the tree improvement orchard and one application was conducted in June.

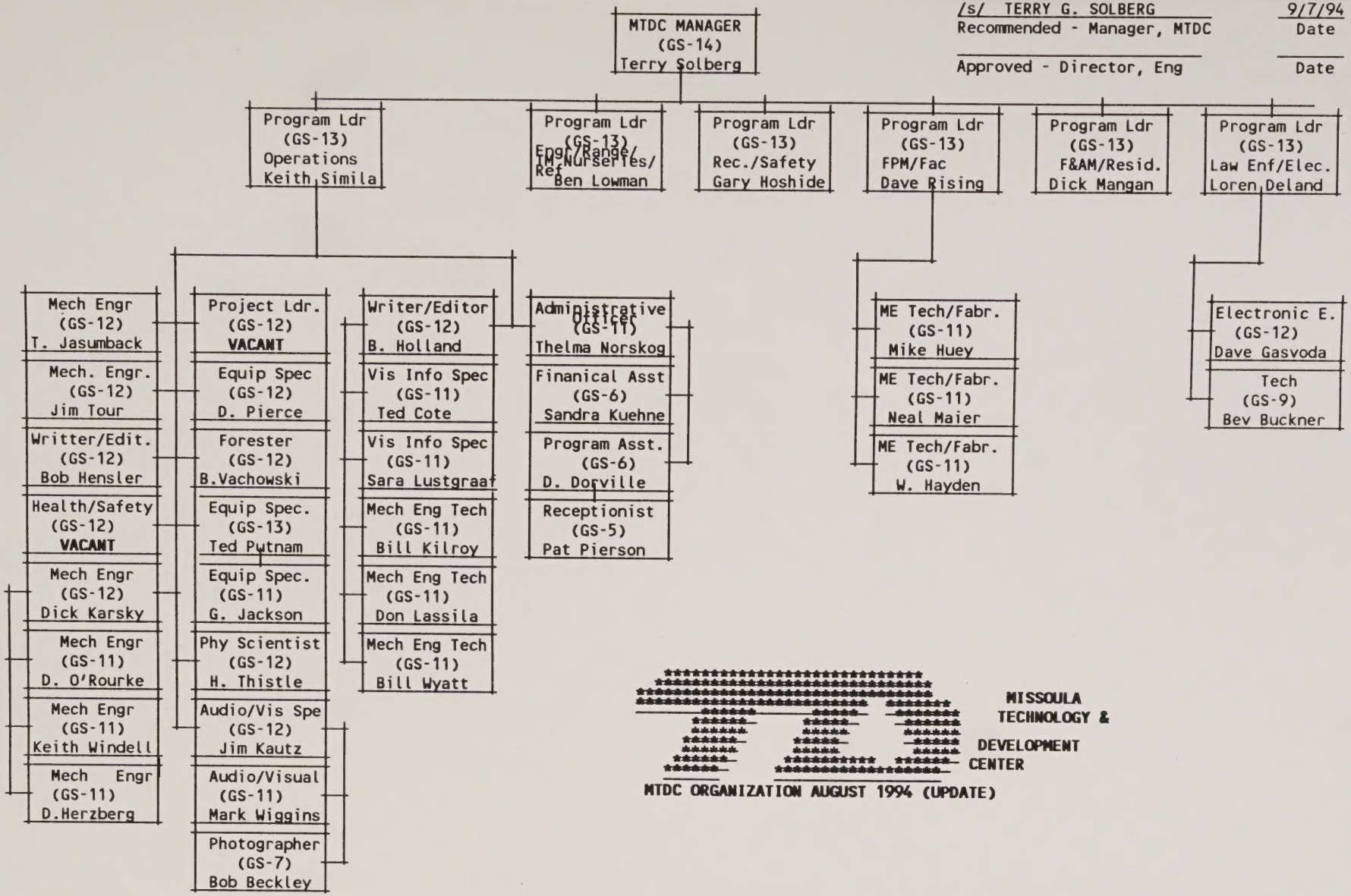
The systems installed in sugar pine trees in California were tested in June 1993. Two of the three systems were operational. The cause of failure was not determined on the non-functioning sprayer.

Single-tree systems were installed in seven trees in the Lookout Pass area on the Montana/Idaho border. The purpose of installing the systems was to determine how durable the systems are after exposure to the elements.

Trip reports are available on request.

/s/ TERRY G. SOLBERG
Recommended - Manager, MTDC — 9/7/94 Date

Approved - Director, Eng — Date



MISSOULA TECHNOLOGY & DEVELOPMENT CENTER

MTDC ORGANIZATION AUGUST 1994 (UPDATE)

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